

Settlement Agreement April - June 2001 Report



**Prepared for the
Technical Oversight Committee
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ARTHUR R. MARSHALL LOXAHATCHEE NATIONAL WILDLIFE REFUGE

Phosphorus Concentrations

The 1991 Settlement Agreement ended the Everglades lawsuit and was entered into by the federal government, the State of Florida and the South Florida Water Management District. The Consent Decree, as modified in 1995, specified that interim and long-term phosphorus concentration levels for the Loxahatchee National Wildlife Refuge (Refuge) must be met by Feb. 1, 1999, and Dec. 31, 2006, respectively. The concentration levels vary monthly because they are calculated as a function of water stage measured at gaging stations 1-7, 1-8C and 1-9 within the Refuge. The stage range within which the interim and long-term level calculations are applicable is 15.42 to 17.14 feet (mean sea level). Total phosphorus concentrations are determined from water samples collected at 14 interior marsh stations (LOX 3 through LOX 16).

Average stages in the Refuge were 15.48, 14.88 and 15.42 feet in April, May and June 2001, respectively (**Figure 1**). The geometric means calculated from total phosphorus concentrations measured in water samples collected in April, May and June were 11.5, 18.3 and 15.1 ppb, respectively (**Table 1**). The geometric mean concentrations in April, May and June were less than the calculated interim and long-term limits. For completeness, the May value is provided in **Figure 1**. However, the May total phosphorus concentration of 18.3 ppb was based on only two samples because many sites were dry or had water levels less than 10 centimeters, the minimum depth necessary to ensure a representative sample. The interim and long-term limits were not applicable in May since the Refuge average stage was less than 15.42 feet (**Table 1**).

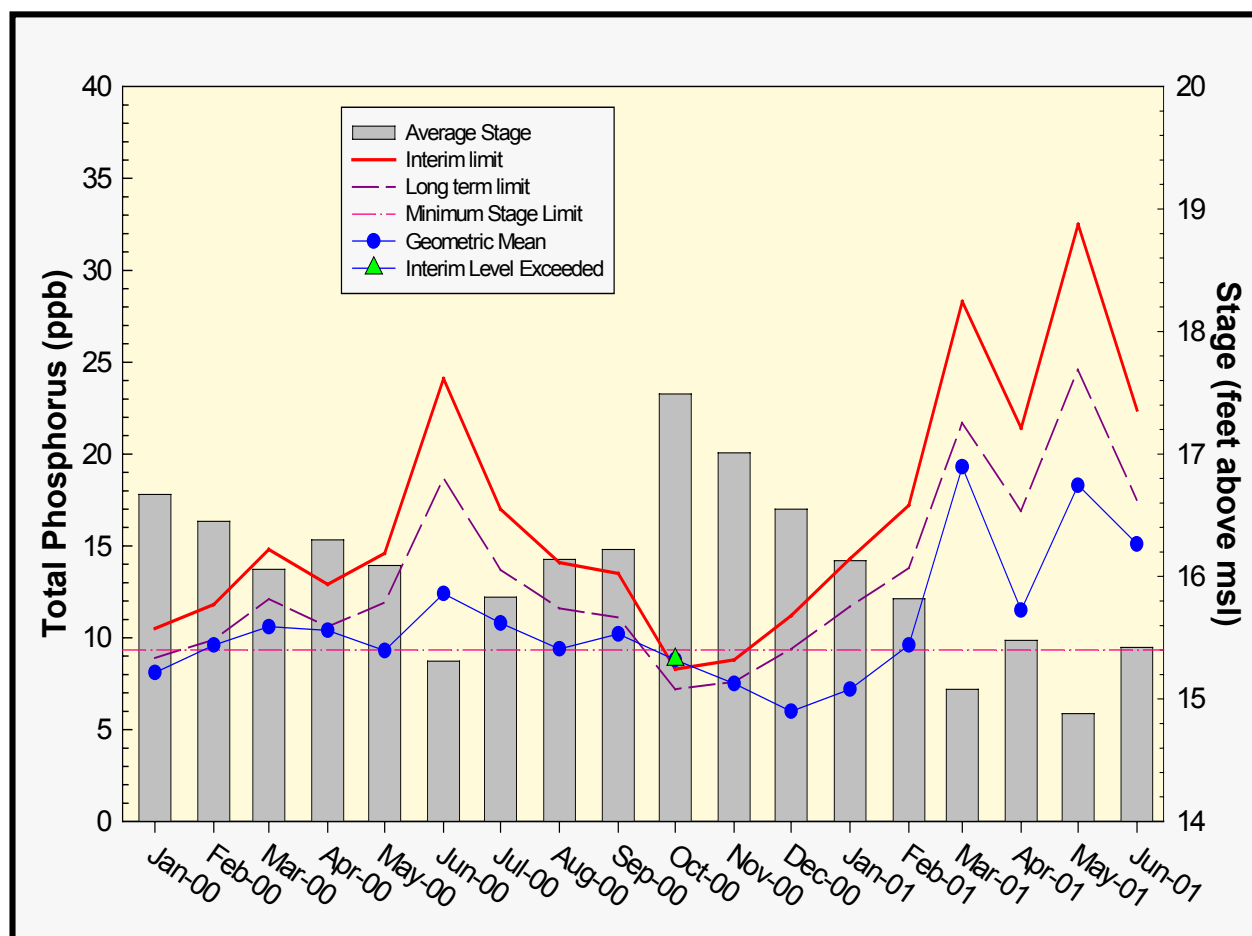


Figure 1. Monthly total phosphorus geometric mean concentration levels for the Loxahatchee National Wildlife Refuge compared to the interim and long-term targets. The calculated target concentrations are adjusted for fluctuations in water level. Due to extremely low stage levels, the geometric mean value for May 2000 is not considered for compliance with the Consent Decree.

Table 1. Loxahatchee National Wildlife Refuge Total Phosphorus Compliance.

Month and Year	Geometric Mean	Interim Limit	Long Term Limit	Average Stage	Number of Phosphorus Samples	Number of Stage Measurements
	(ppb)			(ft, NGVD)		
Jul-1999	11.1	14.4	11.8	16.11	10	3
Aug-1999	12.7	15.1	12.3	16.03	8	3
Sep-1999	10.3	9.9	8.4	16.79	14	3
Oct-1999	10.3	9.9	8.4	16.79	14	3
Nov-1999	10.3	9.9	8.4	16.79	14	3
Dec-1999	9.1	9.1	7.9	16.94	14	3
Jan-2000	8.1	10.5	8.9	16.67	14	3
Feb-2000	9.6	11.8	9.9	16.45	13	3
Mar-2000	10.6	14.8	12.1	16.06	12	3
Apr-2000	10.4	12.9	10.6	16.30	14	3
May-2000	9.3 (11.0)	14.6 (15.0)	11.9 (12.2)	16.09 (16.05)	11 (14,11,13,12)	3 (3,3,3,3)
Jun-2000	12.4	NA	NA	15.31	6	3
Jul-2000	10.8	17.0	13.7	15.83	6	3
Aug-2000	9.4	14.1	11.6	16.1	10	3
Sep-2000	10.2	13.5	11.1	16.22	11	3
Oct-2000	8.8	8.3	7.2	17.49	13	3
Nov-2000	7.5	8.8	7.6	17.01	14	3
Dec-2000	6.0	11.2	9.4	16.55	9	3
Jan-2001	7.2	14.3	11.7	16.13	8	3
Feb-2001	9.6	17.2	13.8	15.82	9	3
Mar-2001	19.3	NA	NA	15.08	2	3
Apr-2001	11.5	21.4	16.9	15.48	6	3
May-2001	18.3	NA	NA	14.88	2	3
Jun-2001	15.1	22.4	17.5	15.42	9	3

Notes:

- (1) Average Stage is calculated using stage elevations at three stations on the sampling date.
- (2) The italicized values in parentheses for May-2000 include the Lake Okeechobee Recession special sampling data.
- (3) Highlighted values indicate months when exceedances occurred.
- (4) NA = Limits not applicable when Refuge stage is below 15.42 feet (mean sea level).

EVERGLADES NATIONAL PARK

Shark River Slough

The Consent Decree of 1995 specified that interim and long-term total phosphorus concentration limits for discharges into the Everglades National Park through Shark River Slough must be met by October 1, 2003, and December 31, 2006, respectively. The limits apply to the water year ending September 30. The long-term total phosphorus concentration limit for inflows to Shark River Slough through structures S12A, S12B, S12C, S12D and S333 represents the concentrations delivered during the Outstanding Florida Waters baseline period of March 1, 1978, to March 1, 1979, and is adjusted for variations in flow. In addition, the Settlement Agreement requires that phosphorus concentrations be presented as 12-month moving flow-weighted means.

Inflow concentrations of total phosphorus through Shark River Slough are compared to the interim and long-term limits at the end of each water year from 1989 to 2000 (**Figure 2a**). The 12-month moving flow-weighted mean total phosphorus concentration ending September 2000 was 10.0 ppb. Corresponding interim and long-term limits were 9.4 and 7.6 ppb, respectively. This is the first time since 1993 that both limits were exceeded for the water year ending in September.

The Settlement Agreement stipulates that the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed a maximum value based on flow into Shark River Slough for the same 12-month period (**Figure 2b**). For the 12-month periods ending April, May and June 2001, the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb was 84.6, 81.8 and 80.0, respectively. These percentages exceeded the allowed percentages for all three 12-month periods (see **Table 2**).

Table 2 presents the moving flow-weighted mean total phosphorus concentrations for each 12-month period from July 1998 through June 2001, as well as the corresponding interim and long-term total phosphorus concentration limits, which are calculated using the 12-month period flow. For the 12-month periods ending in April, May and June 2001, the total phosphorus concentrations were 15.8, 13.7 and 12.8, respectively. These concentrations were all greater than the long-term limits for these respective months, whereas only the June concentration was less than the interim limit.

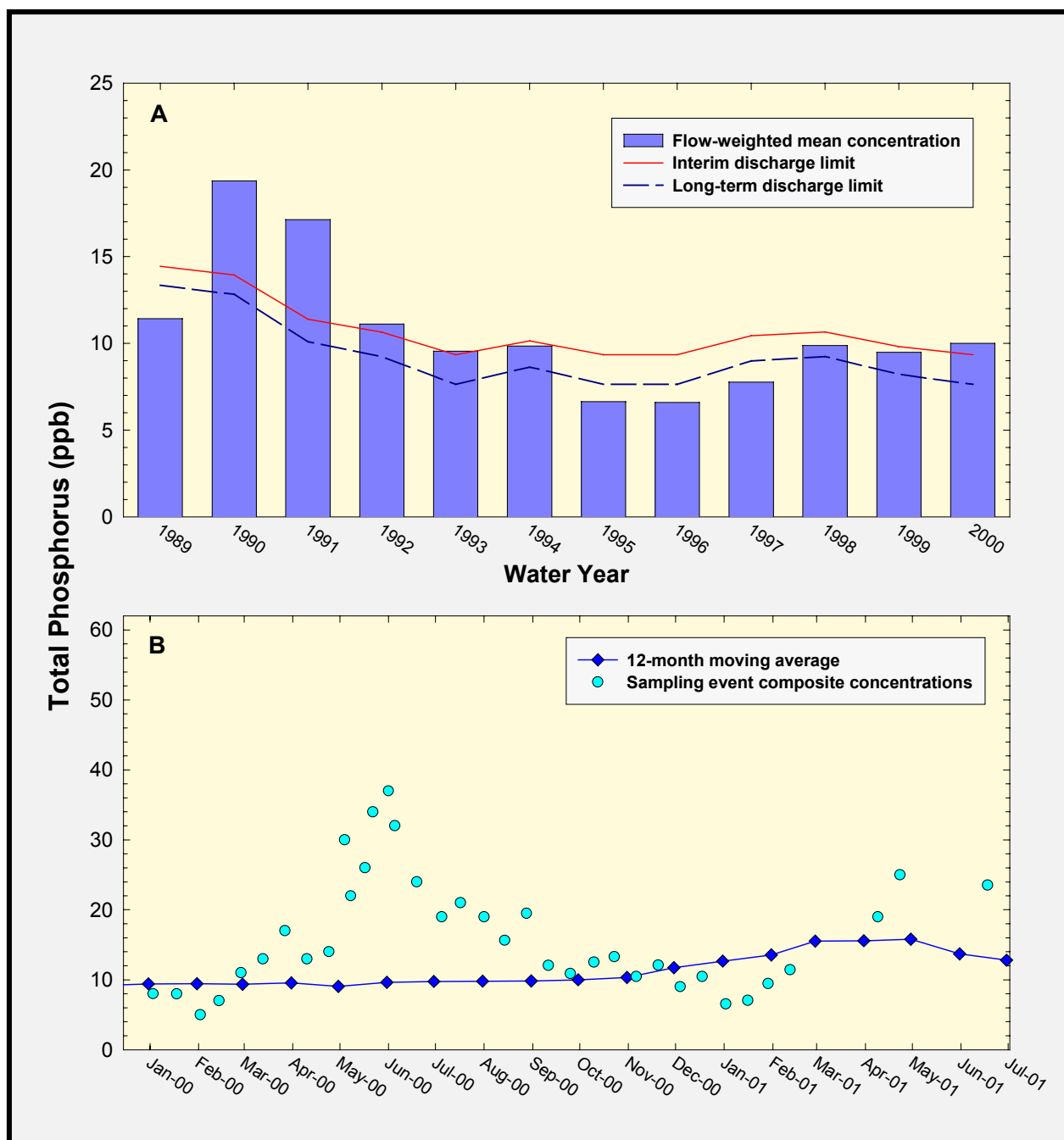


Figure 2. 12-month moving flow-weighted mean total phosphorus concentrations at the inflows to the Everglades National Park (ENP) through Shark River Slough compared to the interim and long-term targets. **a.** Concentration at the end of each water year. **b.** 12-month moving average concentration at the end of each month and the composite concentration for each sampling event.

Table 2. Shark River Slough Total Phosphorus Concentration Compliance Tracking.

12-Month Period Ending On	Total Period Flow (Kac-ft)	Flow Weighted Mean Total Phosphorus (ppb)	Limits (ppb)		Percent of Samples Greater Than 10 ppb (%)	
			Interim	Long Term	Observed	Allowed
7/31/99	788.4	9.7	10.4	9.0	41.7	46.7
8/31/99	857.6	9.6	10.1	8.6	39.1	44.9
9/30/99	939.9	9.5	9.8	8.2	39.1	42.9
10/31/99	1084.4	9.4	9.4	7.6	39.1	40.1
11/30/99	1297.5	9.1	9.4	7.6	39.1	40.1
12/31/99	1344.8	9.4	9.4	7.6	39.1	40.1
1/31/00	1395.1	9.4	9.4	7.6	39.1	40.1
2/29/00	1415.5	9.4	9.4	7.6	41.7	40.1
3/31/00	1385.7	9.6	9.4	7.6	52.2	40.1
4/30/00	1385.1	9.1	9.4	7.6	52.2	40.1
5/31/00	1401.5	9.6	9.4	7.6	57.7	40.1
6/30/00	1395.9	9.8	9.4	7.6	60.7	40.1
7/31/00	1294.6	9.8	9.4	7.6	64.3	40.1
8/31/00	1215	9.8	9.4	7.6	65.5	40.1
9/30/00	1096	10.0	9.4	7.6	69.0	40.1
10/31/00	925	10.3	9.9	8.3	72.4	43.2
11/30/00	642	11.7	11.1	9.8	79.3	50.8
12/31/00	464	12.7	12.0	10.8	82.8	56.4
1/31/01	367	13.5	12.5	11.3	80.0	59.8
2/28/01	298	15.5	12.9	11.7	85.7	62.2
3/31/01	276	15.6	13.0	11.9	84.6	63.1
4/30/01	250	15.8	13.2	12.0	84.6	64.0
5/31/01	231	13.7	13.3	12.1	81.8	64.7
6/30/01	221	12.8	13.3	12.2	80.0	65.1

Note: *Italicized* values exceeded allowed percentage

The daily mean flows through the individual Shark River Slough structures and S334 from January 1999 through June 2001 are presented in **Figure 3a**. From April 1 through June 30, 2001, flows into northeastern Shark River Slough occurred only through S333 from April 9 to April 23 and only through S333 and S12D from June 13 to June 26. The total quarterly flows through S333 were 2839 acre-feet (1431 cfs) and through S12D 666 acre-feet (336 cfs). The relationship between the sum of the daily mean flows at Shark River Slough structures and the corresponding flow-weighted mean total phosphorus concentrations for individual sampling events is presented in **Figure 3b**. Only three composite samples were collected at Shark River Slough structures from April through June with the following results:

<u>Date</u>	<u>Total Phosphorus (fwmc ppb)</u>	<u>Flow (daily cfs)</u>
4/9/01	19	25
4/23/01	25	28
6/18/01	23.5	67

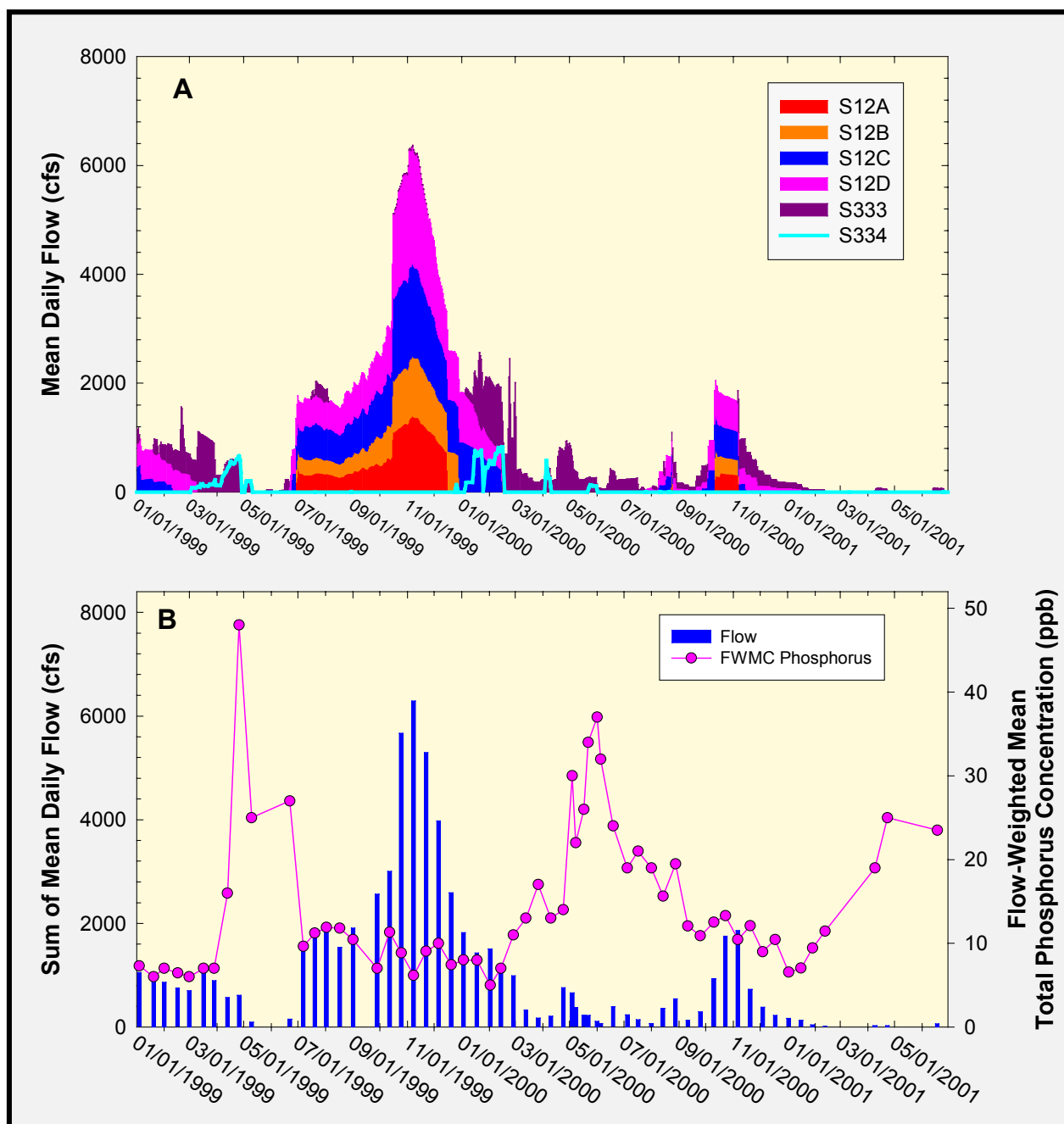


Figure 3. a. Mean daily flows into Shark River Slough by structure. **b.** The relationship between sum of mean daily flow at Shark River Slough structures and flow-weighted mean total phosphorus concentration for individual sampling events.

Taylor Slough and The Coastal Basins

Under the Consent Decree, a single total phosphorus long-term limit of 11 ppb, to be met by December 31, 2006, was set for the two points of inflow to Taylor Slough (S332 and S175) and the inflow point to the Coastal Basins (S18C). The 11 ppb limit applies to the water year ending September 30. Beginning in August 1999, structure S332D, a new pump station constructed by the U.S. Army Corps of Engineers, began operation. The structure is adjacent to spillway S174 and pumps water from the L31N canal into the L31W canal. The S332D and S174 structures became the new inflow compliance monitoring sites for Taylor Slough on October 1, 1999, replacing S332 and S175. However, the Settlement Agreement's Technical Oversight Committee requested that data from both the old and new pairs of inflow structures to Taylor Slough be presented for one year. This request was made to determine if the observed differences between the two data sets from August 1999 through March 2000 would continue throughout a complete wet season/dry season cycle and what implications this might have on future compliance with the 11 ppb limit.

Inflow concentrations of total phosphorus to the Everglades National Park through Taylor Slough and the Coastal Basins are compared to the 11 ppb limit at the end of each water year using data from both the old (S175, S332, S18C) and new (S174, S332D, S18C) combinations of structures for the 2000 water year (**Figure 4a**). The bars in **Figure 4a** represent the flow-weighted mean total phosphorus concentrations from S332, S175 and S18C for water years 1989 through 2000. The diamond point value for water year 1999 represents the total phosphorus concentrations for S174 and S18C from October 1, 1998 through September 30, 1999 plus the S332D data from August 30, 1999 through September 30, 1999. The diamond point value for 2000 represents total phosphorus concentrations for the entire year from S174, S332D and S18C.

Figure 4b presents the 12-month moving average and individual sampling event flow-weighted mean total phosphorus concentrations at both the old and new combinations of structures. A lower than average number of individual sampling event flow-weighted mean total phosphorus concentrations exist from December 2000 through June 2001 due to periods of no flow at the Taylor Slough and S18C structures.

The 12-month flow-weighted mean concentrations for April, May and June 2001 were 7.8, 7.9 and 7.9 ppb, respectively, for the new combination of structures, and 8.7, 9.4 and 9.5 ppb, respectively, for the old combination of structures (**Table 3**). The Settlement Agreement stipulates that the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed a fixed value of 53.1 percent. The percentage of flow-weighted

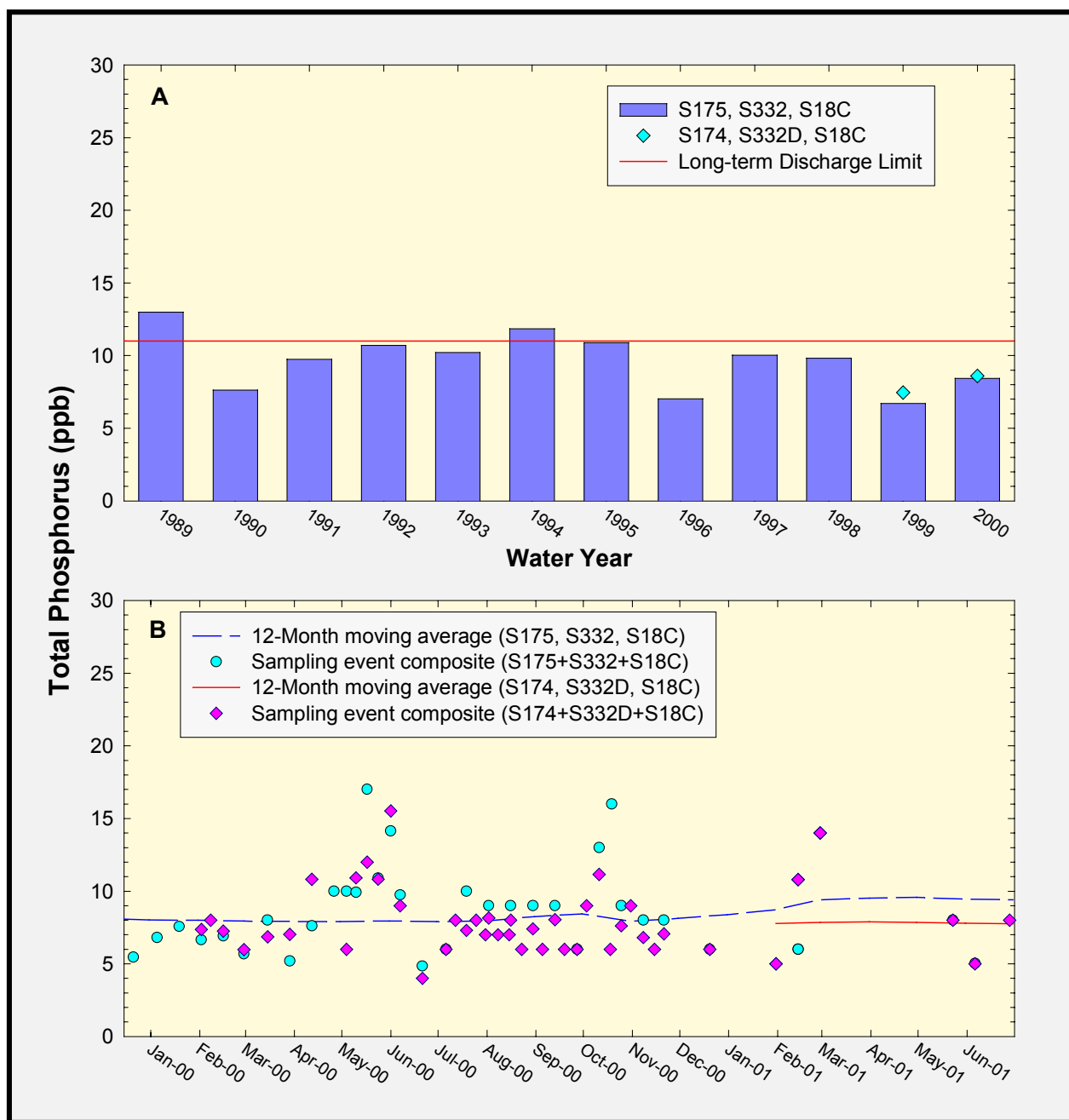


Figure 4. a. Flow-weighted mean total phosphorus concentration at the inflows to the Everglades National Park through Taylor Slough and the Coastal Basins compared to the 11 ppb long-term total phosphorus limit for each year. **b.** The 12-month moving average and individual sampling event flow-weighted mean total phosphorus concentrations at both the old and new combinations of compliance monitoring sites.

Table 3. Taylor Slough and the Coastal Basins Total Phosphorus Concentration Compliance Tracking.

12-Month Period Ending On	Total Period Flow (ac-ft x 10 ³)		Flow Weighted Mean Total Phosphorus (ppb)		Long Term Limit (ppb)	Percent of Samples Greater Than 10 ppb			
						Observed (%)		Allowed (%)	
	New	Old	New	Old		New	Old	New	Old
7/31/99	----	276	----	9.4	11.0	----	25.0	----	53.1
8/31/99	----	288	----	8.5	11.0	----	16.7	----	53.1
9/30/99	----	280	----	6.7	11.0	----	12.1	----	53.1
10/31/99	----	339	----	8.1	11.0	----	17.1	----	53.1
11/30/99	----	365	----	8.1	11.0	----	15.4	----	53.1
12/31/99	----	414	----	8.0	11.0	----	15.4	----	53.1
1/31/00	----	450	----	8.0	11.0	----	15.4	----	53.1
2/29/00	----	479	----	7.9	11.0	----	15.0	----	53.1
3/31/00	----	485	----	7.9	11.0	----	15.4	----	53.1
4/30/00	----	493	----	7.9	11.0	----	12.8	----	53.1
5/31/00	----	493	----	8.0	11.0	----	14.6	----	53.1
6/30/00	----	467	----	7.9	11.0	----	16.7	----	53.1
7/31/00	----	457	----	8.0	11.0	----	17.1	----	53.1
8/31/00	----	445	----	8.3	11.0	----	18.0	----	53.1
9/30/00	----	432	----	8.4	11.0	----	14.3	----	53.1
10/31/00	----	375	----	7.9	11.0	----	12.1	----	53.1
11/30/00	----	315	----	8.1	11.0	----	13.8	----	53.1
12/31/00	----	266	----	8.4	11.0	----	14.3	----	53.1
1/31/01	308	205	7.8	8.7	11.0	15.4	15.4	53.1	53.1
2/28/01	282	168	7.9	9.4	11.0	21.6	16.7	53.1	53.1
3/31/01	269	161	7.9	9.5	11.0	22.9	18.2	53.1	53.1
4/30/01	260	154	7.9	9.6	11.0	20.6	20.0	53.1	53.1
5/31/01	254	153	7.8	9.4	11.0	12.9	11.8	53.1	53.1
6/30/01	249	148	7.8	9.4	11.0	10.0	6.7	53.1	53.1

New= S174+S332D+S18C data

Old = S175+S332+S18C data

mean total phosphorus concentrations greater than 10 ppb for the new combination was 20.6, 12.9 and 10.0 for the periods ending April, May and June, respectively. For these same periods, the percentage for the old combination was 20.0, 11.8 and 6.7, respectively (**Table 3**).

A comparison of flows between the old and new combination of structures is presented in **Figure 5**. The flow through S18C, along with the combined flows through S332 plus S175 and S332D plus S174, is presented in **Figure 5a**. The water discharged from the downstream structures, S175 and S332, is supplied through the upstream structures, S174 and S332D. In April and May 2000, all flow into the Everglades National Park was through S18C. The April total flow was 212 acre-feet (107 cfs), while the May total flow increased to 1089 acre-feet (549 cfs). S18C discharged 4012 acre-feet (2023 cfs) during the month of June and S332D discharged 740 acre-feet (373 cfs) into Taylor Slough during the last three days of June. **Figure 5b** shows the relationship between the sum of the daily mean flows at S18C and the Taylor Slough structures and the corresponding flow-weighted mean total phosphorus concentrations for each sampling event at both the old and new combinations of structures. The zero flow conditions at S174, S332 and S175 throughout the quarter and the flow through S332D from June 28 to June 30 resulted in only three composite samples being collected as follows:

<u>Date</u>	<u>Total Phosphorus (fwmc ppb)</u>	<u>Flow (daily cfs)</u>
5/23/01	8	11
6/6/01	5	40
6/28/01	8	348

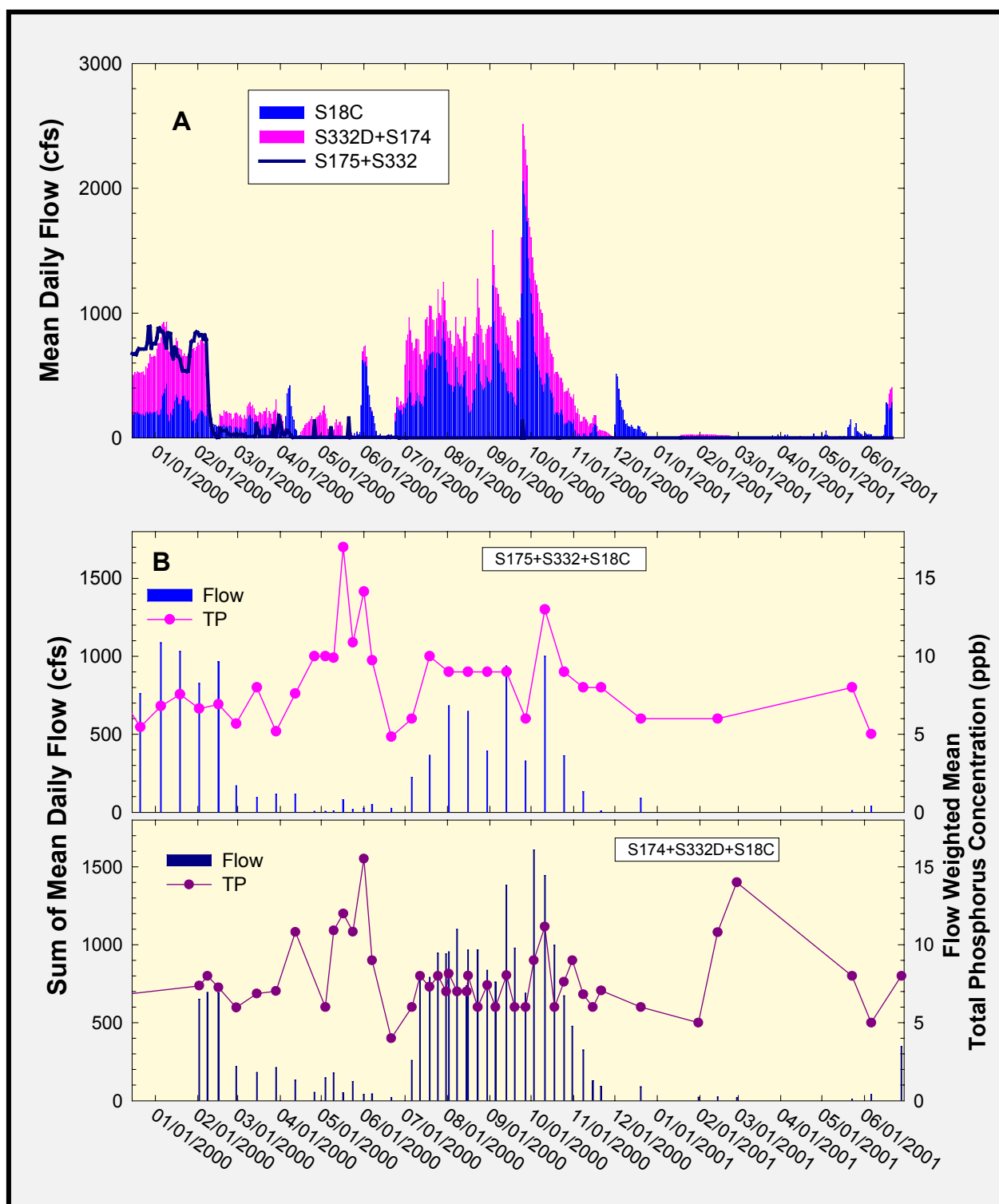


Figure 5. a. Daily mean flows into the Everglades National Park through Taylor Slough and the Coastal Basins control structure. **b.** Mean daily flows and corresponding flow-weighted mean total phosphorus concentrations at old and new combinations of Taylor Slough and Coastal Basin structures.